Online-Appendix: 71 Statements from 39 Sources Identified in the Literature Review on Wicked Problems

Source number	Authors	Source	Related Success Dimensions	Statement (direct quote; highlight by bold font added)
1	Alrøe and Noe, 2014	Constructivist Foundations	Participants – Diversity	The problems that are most in need of **interdisciplinary cooperation** are "wicked problems" such as food crises, climate change mitigation, and other resilience and sustainability problems (Klein 2004).
2	Australian Public Service Commission, 2018	Australian Public Service Commission	Activities	Because wicked problems are often imperfectly understood it is important that they are widely **discussed by all relevant stakeholders** in order to ensure a **full understanding** of their complexity.
			Participants – Diversity	A key conclusion of much of the literature about wicked policy problems is that effectively engaging the **full range of stakeholders** in the search for solutions is crucial.
3	Batie, 2008	American Journal of Agricultural Economics	Activities	There are many engagement methods and techniques that can enhance engagement and link researchers with users. One technique is **discourse** enabled by computer-aided dispute resolution models;
4	Brunswicker, Bilgram and Fueller, 2017	Business Horizons	Content – Diversity	Specifically, prior work informs us that the problem-solving process used to tame wicked problems should support the development of **solutions that are integrative** and contextualized. [...]
				Additionally, the wicked problem-solving process should support the development of **contextualized solutions that consider local circumstances** (Conklin, 2005; Innes & Booher, 2010).
			Activities	To develop a rich understanding of the **controversial perspectives of different stakeholders**, it is particularly important to **stimulate a dialogue-based process** via which participants can raise issues and share their subjective perspectives, which are often contradictory to one another (Conklin, 2005; Innes & Booher, 2010; Kunz & Rittel, 1970).
			Participants – Diversity, Content – Diversity	Thus, both **experts and non-experts** should be involved in the problem- solving process as they both hold **critical, practical knowledge** of the problem at hand
			Participants – Diversity	Wicked problem solving should **actively involve the stakeholders affected** by the problem; as stated by Rittel (1972, p. 354), ''nobody wants to be 'planned at.'"
			Content – Diversity	Specifically, prior work informs us that the problem-solving process used to tame wicked problems should support the development of solutions that are **integrative and contextualized.** Developing integrative solutions is necessary because ''the **expertise** [that] you need in dealing with a wicked problem is usually **distributed over many people**" (Rittel, 1972, p. 394)
			Participants – Diversity	Developing integrative solutions is necessary because ''the **expertise** [that] you need in dealing with a wicked problem is usually **distributed over many people''** (Rittel, 1972, p. 394)
5	Cajot et al., 2017	Sustainable Cities and Society	Collective Learning – Understanding	He emphasizes rather the need for coherence and **shared understanding** of all issues among stakeholders, to avoid the fragmentation of the problem and failing to address the overall issue at stake.

6	Camillus, 2008	Harvard Business Review	Activities, Participants – Diversity, Collective Learning – Understanding	They should organize brainstorming sessions to identify the various aspects of a wicked problem; hold retreats to encourage executives and **stakeholders** to share their perspectives; run **focus groups to better understand stakeholders' viewpoints;** involve stakeholders in developing future scenarios; and organize design charrettes to develop and gain acceptance for possible strategies.
			Activities	Companies must go beyond obtaining facts and opinions from **stakeholders;** they should involve them in finding ways to manage the problem
			Collective Learning – Understanding, Activities	Not everyone will agree on what the problem is, but stakeholders should be able to **understand one another's positions** well enough to **discuss** different interpretations of the problem **and work together** to tackle it.
			Content – Diversity	Getting a **variety of opinions** helps companies develop novel perspectives
7	Conklin, 2006	Book	Collective Learning – Understanding	Coherence means that a wicked problem is recognized as such, and appropriate tools and **processes** are constantly used **to "defragment" the project**. With increased coherence, more **collective intelligence** becomes available to deal with change and complexity. Coherence means that despite social complexity there is a sense of ability and confidence in crafting **shared understanding** and negotiating shared meaning
			Iteration	Wicked problems demand an opportunity-driven approach; they require making **decisions, doing experiments,** launching pilot programs, testing **prototypes,** and so on.
				These experienced designers illustrated that **problem understanding** can only come from creating possible solutions and considering how they might work. Indeed, the problem often can best be described in terms of solution elements.
			Participants – Diversity, Activities	Rittel's genius shines especially bright when we consider his solution for wicked problems: IBIS, a structure for **rational dialogue** among a **set of diverse stakeholders**
8	Davies, Fisher, Dickson, Thrush and Le Heron, 2015	Ecology and Society	Participants – Diversity	Input from a **diverse group of stakeholders** improves the capacity of ecosystem service approaches to address wicked problems by acknowledging **diverse sets of values** and accounting for **conflicting world views.**
9	DeLiddo and Buckingham Shum, 2010	Conference: CSCW 2010	Collective Learning – Awareness & Understanding, Activities	We propose an initial set of high-level functional requirements for the ideal CCI platform: A CCI platform builds **collective awareness** of contested knowledge • A CCI platform builds **collective understanding** of the nature of agreements and disagreements; • A CCI platform builds collective understanding of ways to resolve disagreements.
			Content – Diversity, Participants – Diversity, Activities	This paper introduces the rationale for Contested Collective Intelligence (CCI), which we propose as significant in organizational CI (but equally, in learning across many contexts): 1. there may not be one **worldview** subscribed to by all; 2. evidence can be ambiguous or of dubious reliability requiring the construction of plausible, possibly **competing narratives**; 3. growth in intelligence results from learning, which is socially constructed through **different forms of discourse, such as dialogue and debate.**

10	Duckett, Feliciano, Martin-Ortega and Munoz-Rojas, 2016	Landscape and Urban Planning	Activities, Collective Learning – Convergence	to use different participatory approaches (strategy 4a Fig. 1). This is formulated, variously, as **effective engagement** (Batie, 2008), **integration of knowledges** [sic.]**, social learning,** accommodation of multiple alternatives, group exploration (Mascarenhas, 2009), dialogue mapping and deliberation (Conklin, 2010). Suggestions also include some more concrete frameworks such as adaptive co-management (Berkes, 2011), and collaborative rationality (Innes & Booher, 2010), both of which explicitly prescribe the necessity to go beyond participation and towards **active collaboration throughout the whole planning and decision-making process.**
			Participants – Diversity	Some authors propose an explicitly interdisciplinary or transdisciplinary approach (strategy 2a, Fig. 1): the distinction being that an interdisciplinary approach entails integration across different scientific disciplines whereas **transdisciplinary** entails the **incorporation of other strands of knowledge including non-academic knowledge** (Tress, Tress, & Fry, 2004).
			Iteration	In response, some of the reviewed literature refers to a participatory re-framing of the problem through **iterative processes** (strategy 5a, Fig. 1) that is, sharing views at **different stages of the process** to reframe the problem. This includes the proposals by van Bueren et al. (2003), Coyne (2005), Batie (2008), Conklin (2010), Palmer (2012), van Latesteijn and Rabbinge (2012) and Schooneveldt (in Brown et al. (2010))
11	Edzen, 2014	Conference: HICSS 2014	Participants – Diversity	Huthinson [20] suggests a team-based approach to planning for and solving wicked problems. A team consists of individuals who have **knowledge relevant to every aspects** [sic.] **of the problem.**
12	Eldabi, 2009	Conference: WSC 2009 (IEEE)	Collective Learning – Convergence	When it comes to approaching wicked problems we need to think about a **resolution** rather than a solution and a **consensus** rather than optimization.
13	Feldgen and Clua, 2012	Conference: FIE 2012 (IEEE)	Iteration	Wicked problems require an ongoing **iterative analysis** between problem and solution to begin to understand either. [..] The process of solving a wicked problem is inherently non-linear. Progress is defined qualitatively in terms of how much more is understood about the problem rather than distance from the solution.
14	Ferro, Loukis, Charalabidis and Osella, 2013	Government Information Quarterly	Activities, Collective Learning – Understanding & Convergence	So Rittel and Weber (1973) suggest that wicked policy problems require 'second generation' methods, which combine in a first stage consultation among problem stakeholders, in order to formulate a **shared definition of the problem**, and then in a second stage mathematical analysis by experts. In particular, in the first stage **discourse and negotiation** take place, aiming to **synthesize different views** and opinions, and finally **formulate a shared definition** of the problem and the objectives to be achieved
15	Fleming and Howden, 2016	Science of the Total Environment	Participants – Diversity	Diversity, **interdisciplinarity and transdisciplinarity** are now recognized as vital to tackling wicked problems such as those presented by a changing climate. (Nature editorial, 2015, Ledford, 2015; Dick et al., 2016).
16	Head, 2008	Public Policy	Activities	The widely recommended strategy of more effective consultation and closer **'collaboration' among stakeholders** as a process solution is also important (Roberts 2000; Mandell 2001; Management Advisory Committee 2004; Goldsmith and Eggers 2004; and APSC 2007).
17	Head and Alford, 2015	Administration & Society	Activities, Participants – Diversity	The presence of **collaborative relationships** is likely to enhance the understanding and addressing of those wicked problems where there are **multiple parties with differential**

				knowledge, interests, or values. [...] This not only arises in part from a shared ownership of the **deliberative process** (Gunton & Day, 2003; Tett, Crowther, & O'Hara, 2003) but also arises from the involvement of a **wider array of actors**, offering more diverse insights into why a situation has arisen.
18	Head, Ross and Bellamy, 2016	Landscape and Urban Planning	Participants – Diversity	Working with wicked problems 'requires a **holistic** and **process oriented** approach that is by nature adaptive, participatory, and **transdisciplinary'** (Xiang, 2013, p. 2)
19	Head and Xiang, 2016	Landscape and Urban Planning	Activities	wicked problems cannot be "solved" as such through standard science-based approaches; rather, they need to be "tackled, managed and dealt with" through **collaborative processes**. Understanding and addressing such problems cannot be revealed simply through positivist social science, but only through the open and participatory **processes of engagement and knowledge-sharing.** [...] The most obvious requirement is to develop explicit approaches to **knowledge-sharing among stakeholders** and decision-makers (Balint et al., 2011; Davies, Fisher, Dickson, Thrush, & Le Heron, 2015).
			Participants – Diversity	**Transdisciplinary teams** are called upon to research and resolve problems associated with socio-ecological systems, which are notoriously wicked.
20	Inghelbrecht, Dessein and van Huylenbroeck, 2014	NJAS - Wageningen Journal of Life Sciences	Participants – Diversity, Collective Learning – Understanding	As there are no true solutions to solve a wicked problem, addressing it requires **multi-stakeholder engagement** (from industry, amongst others) in order to reach a **shared understanding** of a common problem. [...] Managing a wicked problem is the shared responsibility of multiple stakeholder groups.
21	Innes and Booher, 2016	Landscape and Urban Planning	Activities, Content – Diversity	In this essay we make the case for a different kind of rationality, built on **collaborative dialogue** and **multifaceted information**, as a strategy for dealing with what appear to be wicked problems. Such dialogue, properly conducted, can get players to back off rigid positions and find other options that further their interests, to **cooperate** in ways that enlarge the pie for all, to learn not just new ways of solving problems, but also to acquire the insights to reframe the wicked into the manageable, and ultimately to rethink goals and purposes to be more realistic. [...] Information plays a central role in collaborative dialogue, and **working through discrepancies and differences among knowledge sources** can produce more accurate and meaningful information than can a lone expert or a single study
			Activities, Collective Learning – Understanding	Participants articulate their interests in the issue and are discouraged from position-taking until late in the process after they **have learned in more depth about the situation, understood others' interests**, and had the chance to consider new possibilities.
			Participants – Diversity	Participants are **diverse, representing the variety of points of view** on the issues. Leaving out an inconvenient opponent can mean that results will not be robust or legitimate. […] Expert as well as community knowledge are both part of the dialogue
22	Introne, Laubacher, Olson and Malone, 2013	German Journal of Artificial Intelligence	Content – Diversity, Participants – Diversity	Generally speaking, winning **proposals have been diverse**, creative, serious contributions **from people all over the world.**
23	Ireland, Rapaport and Omarova, 2012	Procedia Computer Science	Content – Diversity	Therefore completely different evaluations of social systems will inevitably exist. 'The only way we can get near a view of the whole system is to look at it from **many different perspectives as possible**
24	Jantunen, Lehtola, Gause,	Conference: IWSPM 2011		Hence, coping with a wicked problem through the process of sensemaking is fundamentally a **social process** [57], where there is no distinct phase of data analysis but rather different

	Dumdum and Barnes, 2011		Content – Diversity, Collective Learning – Understanding	kinds of **conversations** between **problem understanding and solution formulation** that must be woven together from beginning to end [57].
				The attempt to utilize the collective mind of a product's stakeholder network introduces benefits that cannot easily be accomplished with linear and authorative strategies. The collective mind is likely to be more effective in divergent thinking [54], generating a **wide range of ideas** and surfacing important aspects of the problem.
25	Ketter, Peters, Collins and Gupta, 2015	MIS Quarterly	Participant – Diversity, Content – Diversity, Collective Learning – Understanding	Wicked problems exceed the capacity of individual research groups to interact with **all stakeholders** to build and maintain an understanding of an unfolding challenge (Arias et al., 2000). Bringing **different** and often **controversial points of view** together to create a **shared understanding** among these stakeholders can lead to new insights, new ideas, and new artifacts.
			Participant – Diversity	Research on wicked problems must consider a broad range of diverse candidate interventions based on experiences of researchers and **stakeholders from various disciplines** to understand the nature of good interventions in the absence of a unique quality criterion (Pries-Heje and Baskerville, 2008; Collins et al., 2009).
26	Malone et al., 2009	Working Paper (MIT Collective Intelligence Center)	Activities, Content – Diversity	For wicked problems like climate change, it is unlikely that any single model or combination of models will reflect all the issues and points of view that need to be considered in making a decision. Instead, it is important to be able to capture and share the **different perspectives and arguments** relative to different aspects of the decision. [...] Therefore, the third key element of the Collaboratorium involves **users** voting to **express their opinions** and preferences
27	Pacanowsky, 1995	Organizational Dynamics	Iteration	Wicked problems necessarily have an **iterative nature** to them, as we cycle through the phases of problem definition, information gathering, solution, and outcome. It can be said that we do not really "solve" wicked problems; rather, we "design" more or less effective solutions based on how we define the problem.
28	Pretorius, 2017	South African Computer Journal	Activities, Collective Learning – Understanding	**Participation and collaboration** - most commonly cited requirement; stresses the importance of supporting **collaborative understanding** of the wicked problem situation
			Activities	Transparency and accessibility of evidence - capturing evidence of the **various perspectives** or positions outlined above and making this clearly and freely **available to all stakeholders**
			Content – Diversity, Activities	The literature postulates that rather than ignoring these **conflicting views**, they should be **explored and reasoned through** in a space that is considered safe for all stakeholders.
29	Raisio, 2009	Journal of Health Organization and Management	Participant – Diversity & Quantity	According to these views, to survive wicked problems we need to think holistically, **work with as many different people as possible**, include citizens in the planning and decision making, and start thinking and working in fundamentally novel and creative ways.
30	Raisio and Vartiainen, 2015	Policy Sciences	Activities, Collective Intelligence – Understanding & Convergence	This research set out to examine the role of public deliberation in tackling wicked policy issues. Such issues are commonly associated with fragmentation and incoherence. Deliberative mechanisms are thought to encourage public judgment, a form of **shared understanding** where the citizens truly strive to understand the complexity of the wicked issue and **together, in deliberation, seek the best ways to address it** (Yankelovich 2011).

				[...] The direct aim is not to achieve consensus, but that the all participants, regardless of any disagreements, **accept the result to be fair and justified**. This kind of mutual justifiability where ‘‘participants in deliberation are engaged, with mutual respect, as free and equal citizens in a search for fair terms of cooperation’’ (Mansbridge et al. 2010: 94) would ideally help to process wicked policy issues.
31	Rittel, 1972	Bedriftsøkonomen (Norwegian journal of economics and management)	Activities	The planning process of wicked problem solving must be understood as an **argumentative process:** one of **raising question and issues** towards which you can assume different positions.
			Participants – Diversity	Those people who are the **best experts** with the best knowledge, are usually those who are likely to be **affected by your solution**. Hence ask those who become affected and not the experts.
			Activities	Therefore, we should draw the conclusion and say, **everybody is entitled to exert his judgment** about the plan. We need procedures which enable us to **explain to each other why** I think that it is great and you think it is lousy.
			Participants – Quantity	The **expertise** which you need in dealing with a wicked problem is usually **distributed over many people.**
32	Rittel and Webber, 1973	Policy Sciences	Activities	Approaches of the "second generation" should be based on a model of planning as an **argumentative process** in the course of which an image of the problem and of the solution emerges gradually among the participants, as a product of incessant judgment, subjected to critical argument.
			Content – Diversity	Problem understanding and problem resolution arc concomitant to each other. Therefore, in order to anticipate all questions (in order to anticipate all information required for resolution ahead of time), **knowledge of all conceivable solutions is required.** [...]
			Iteration	**Each attempt** at creating a solution changes the understanding of the problem
			Participants – Diversity	For wicked planning problems, there are no true or false answers. Normally, **many parties** are equally equipped, interested, and / or entitled to judge the solutions, although none has the power to set formal decision rules to determine correctness. Their **judgments are likely to differ widely** to accord with their group of personal interests, their special value-sets, and their **ideological** predilections.
33	Roberts, 2002	Book	Participants – Diversity	One step to move people beyond their ‘my-truth-is-better-than-your-truth’ positions is to **get “the whole system in the room”** so stakeholders can begin to listen and learn from one another (Bunker & Alban, 1997). The ideal in such undertakings is to learn that each person holds ‘some truth’ in dealing with their wicked situations.
			Activities	[...] **Central to a collaborative strategy is dialogue.** As Bradley demonstrates in Chapter 10, dialogical communication is the necessary condition for collaboration to be successful.
34	Schoder, Putzke, Metaxas, Gloor and Fischbach, 2014	Business & Information Systems Engineering	Activities, Iteration	Resolving wicked problems requires parallel **discourse, multiple iterations**, changes of beliefs, and unpredictable revisions

35	Sharts-Hopko, 2013	Nursing Outlook	Participants – Diversity	Solving wicked problems demands that people think critically about theoretical constructs in their own and related disciplines at and even **beyond disciplinary limits** with a futuristic orientation. [...] Strategies demand the development of groups of individuals representing a **variety of relevant disciplines** who are focused on the problem, rather than discipline-specific approaches.
			Activities	Rather, the challenge is to assess current relevant knowledge from a **variety of theoretical and disciplinary perspectives**, to think about all of the contextual factors we can possibly imagine to be related to these issues, and to then use that foundation to logically consider thought questions based on the best current information and within a multidisciplinary **dialogue.**
36	Tietjen and Jørgensen, 2016	Landscape and Urban Planning	Participants – Diversity	Scholars in environmental planning have framed climate change and sustainability issues as wicked problems and have prescribed **multi-actor networks and collaborative partnerships** to address them (Artman, 2015; Detoni & Bitzer, 2015; Frame, 2008; Hartmann, 2012; Hocking, Brown, & Harris, 2016; Perry, 2015).
37	Willis, 2016	Public Relations Review	Activities	Given **dialogue** in wicked contexts is presented as the only viable option for problem resolution it begins to align what has been hitherto regarded as a normative conception of PR practice with a necessary condition of organizational resilience and sustainability.
38	Xiang, 2013	Landscape and Urban Planning	Participants – Diversity, Iteration	Instead of the partial and linear strategy of divide and conquer that aims at searching for definitive solutions, it requires a holistic and **process oriented approach** that is by nature adaptive, **participatory,** and **transdisciplinary**
39	Zijp, Posthuma, Wintersen, Devilee and Swartjes, 2016	Environment International	Iteration	Finding solutions for wicked problems is seen as an **iterative process**, so that **adaptive management** is key part of the assessment process. [...] The success of the implementation of a chosen solution is **evaluated iteratively**, forming new SfSA cycles when needed. This evaluation again includes stakeholder participation, because the view on the degree of solving a problem depends on ones view on the problem (Gorman et al., 2012)
			Participants – Diversity & Quantity	Wicked problems often require inclusion of many stakeholders and/or general public consultation.

References

For detailed reference information, please refer to the original article:

Gimpel, H., Laubacher, R., Parak, D., Schoch, M., & Wöhl, M. (2023). Managing the Inner Workings of Collective Intelligence Approaches for Wicked Problems – An Assessment Model and Evaluation. Communications of the Association for Information Systems, 52. Retrieved from https://aisel.aisnet.org/cais/vol52/iss1/43